



Armed Forces College of Medicine AFCM



Biochemical basis Obesity & weight regulation

By

Dr. Amal El-Shal

Assistant professor of Biochemistry

Intended Learning

Outcomes

By the end of the module, students should be able to:

- 1. Interpret the biochemical basis of body weight regulation**
- 2. Enumerate the causes of obesity**
- 3. Outline effect of obesity**



Case scenario



A 49 -year- old married **woman**, 158 cm tall and weighting **108** Kg came for consultation to a physician complaining of increased weight. She was too worried about her weight gain.

- She has **sedentary life** style. Her dietary habits revealed **high caloric diet** and absent consumption of vegetables and fruits



During routine physical examination



the patient was observed to be hypertensive (blood pressure of **200/120** mm Hg).

- The patient was asked to return to the clinic during fasting state and blood specimen was obtained.
- Lab investigation revealed:



Normal range

Parameter

What is the most likely diagnosis?

mg/dl 70

Glucose fasting

mg/dl 120

obesity

mg/dl 280

Total cholesterol

mg/dl 120

Triglycerides

150mg/dl >

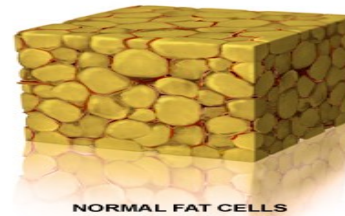
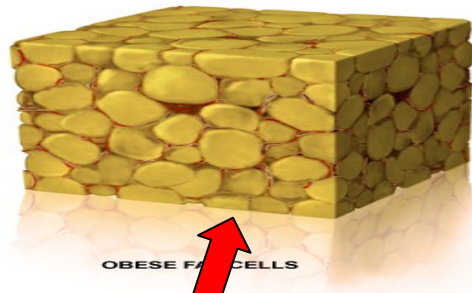
mg/dl 177

What is Obesity?



Definition:

Obesity is a disorder of body weight regulatory systems characterized by an accumulation of **excess body fat (increase fat cells size and number) either generalized or localized**



Expansion of fat cells



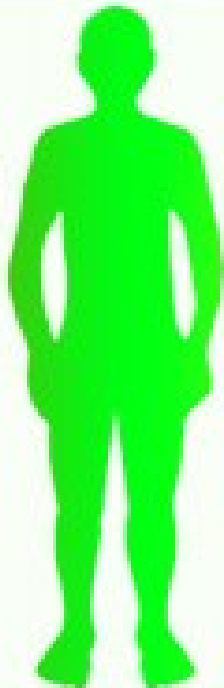
WHO classified the weight according to body mass index (BMI) into:

Body Mass Index - (Kg/m²)

Below 18.5
Underweight



18.5 to 24.9
Normal



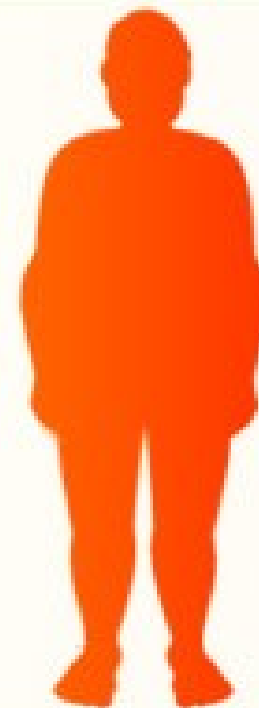
25 to 29.9
Overweight



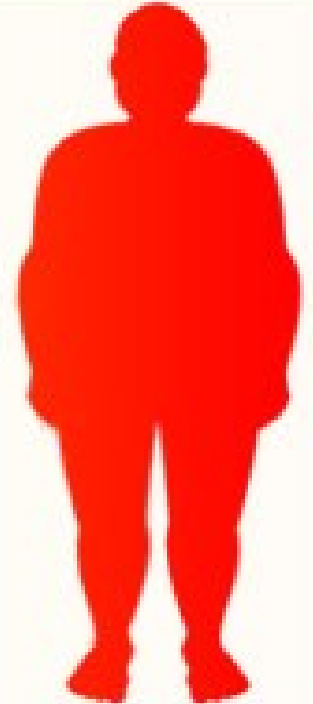
30 to 34.9
Obese class I



35 to 40
Obese class II



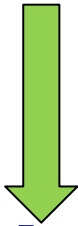
Above 40
Obese class III



Regulation of body weight

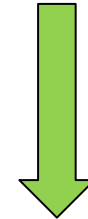


Long term signals
(Hormones)



- 1- Leptin** (satiety hormone)
- 2- Insulin**

short term signals
(minutes to hours)



1-GIT hormones

- **Hunger: Ghrelin**
- **After meal: CCK, PYY**

2-Neural signals

3-Hypothalamal



1 - Leptin (satiety hormone)

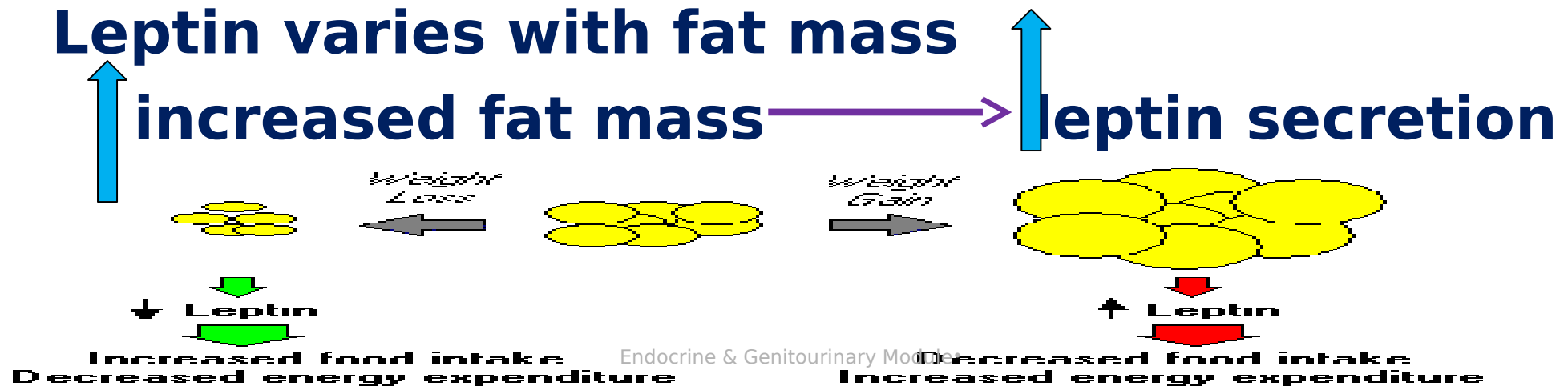


- Site of synthesis:

- Leptin is a **hormone** secreted mainly from white adipose tissue.
- Can be produced in **very small** amount by placenta, skeletal muscle, stomach, liver, bone marrow, and mammary glands.

- Eating (**meal**) → **stimulate** leptin secretion

- Blood level:



1 - Leptin (satiety hormone)



- **Function:**
- **Increase energy expenditure (loss)**
- **It considered a satiety hormone through:**

A. Directly:

Stimulate satiety center → **(stop eating & Decrease appetite).**

B. Indirectly:

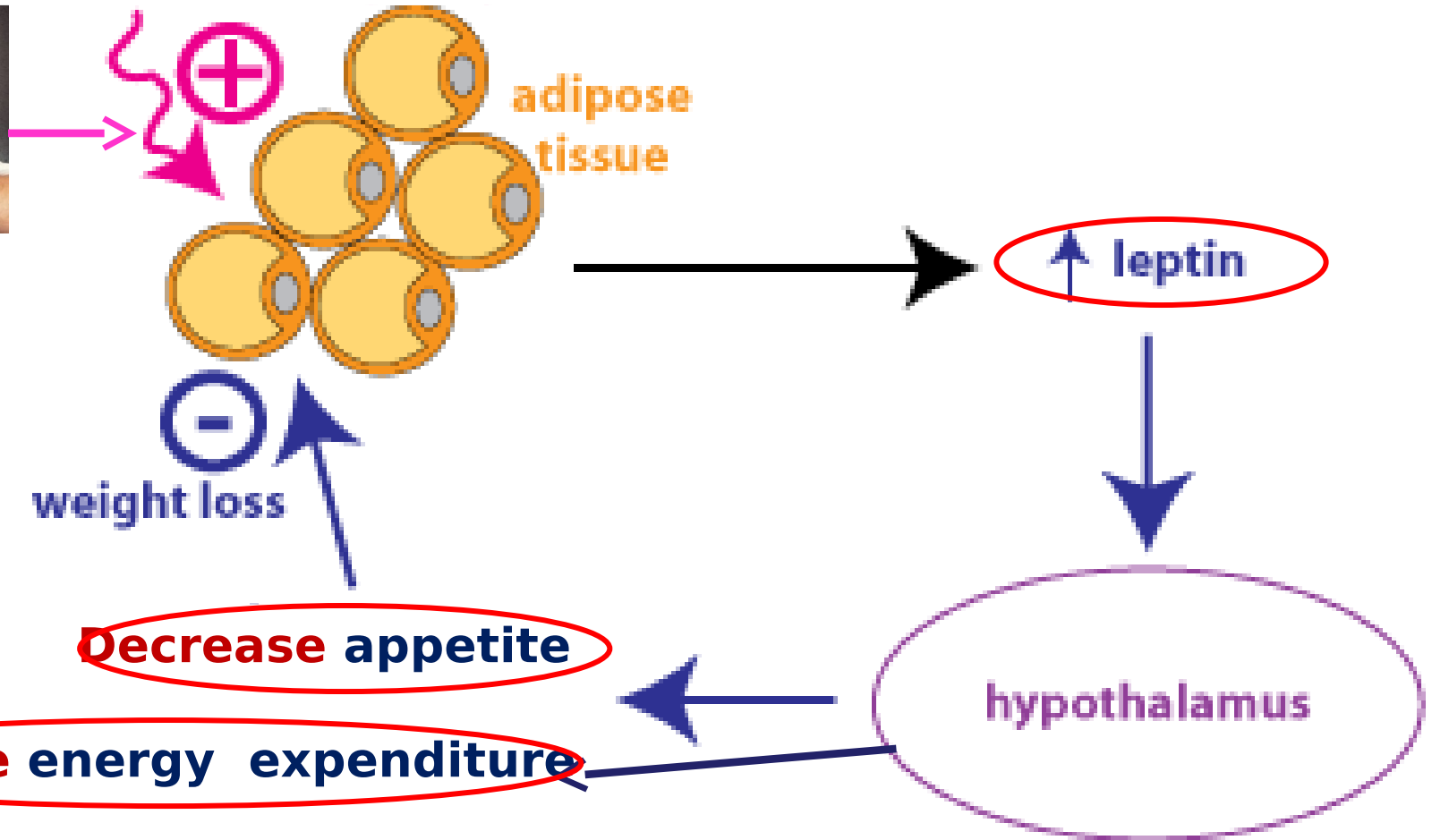
- I. **Leptin can increase the sensitivity of hypothalamic satiety center to Cholecystokinin (CCK) leads to satiety**
- II. **Leptin can decrease the sensitivity of hypothalamic hunger center no hunger sensation**



1 - Leptin (satiety hormone)



Food intake (eating)



What about Leptin levels in obesity?



1. Why leptin levels increased in obese person?

**Due to increased
body fat mass in
obese person**

**But there is resistance to
this leptin**



Insulin -2

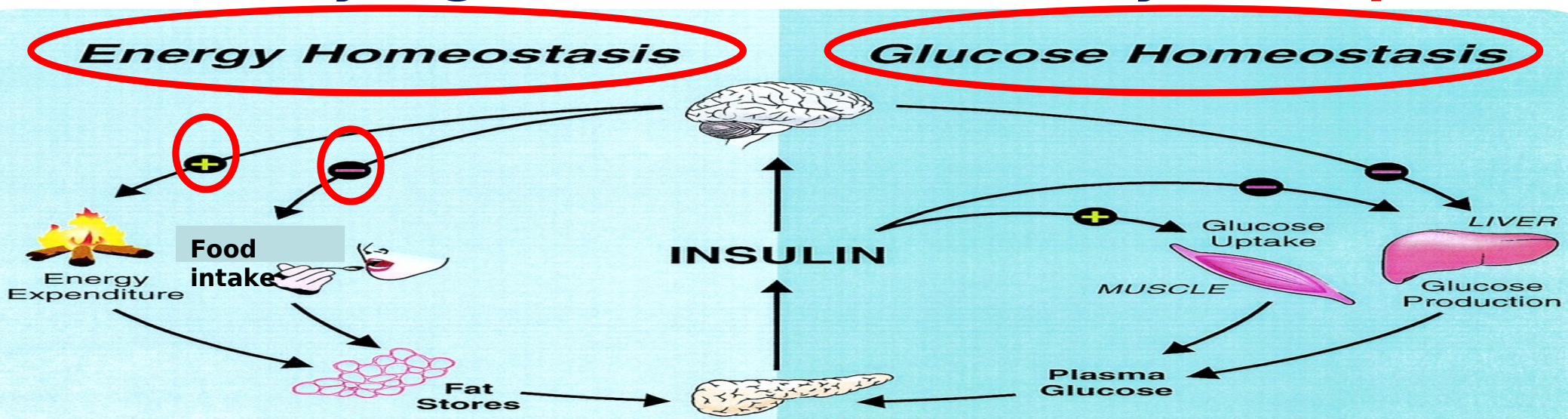


- Insulin hormone secreted by β cells of pancreas
- A meal (eating) \rightarrow blood glucose level \rightarrow stimulate

insulin secretion which leads to:

1-Decrease food intake :

through increased sensitivity of satiety center to satiety signals \rightarrow feel of satiety \rightarrow stop



B. Short-term signals (minutes to hours)



- **Short-term signals from the gastrointestinal tract control hunger and satiety.**
- **They affect the size and number of meals**



GIT hormones-1



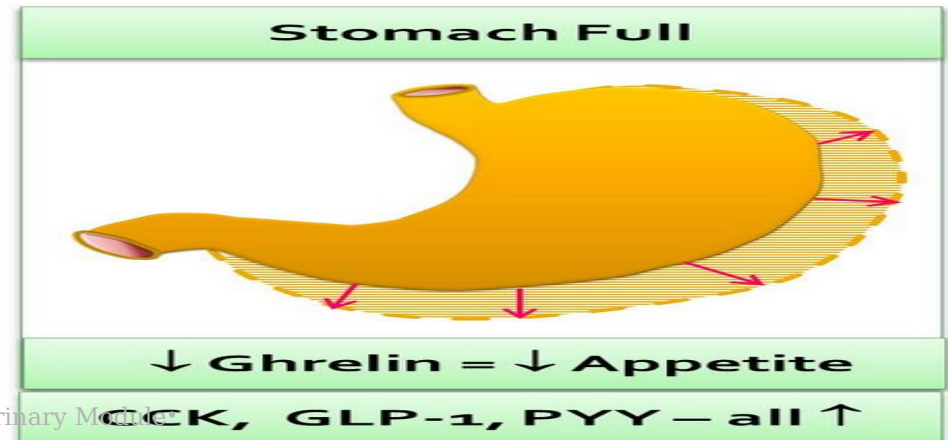
A) In the absence of food intake (between meals)

1. Ghrelin (appetite-stimulating) "hunger hormone"

Source:

produced by ghrelinergic cells in the gastrointestinal tract

• Function



B) After meal



Cholecystokinin-2 (CCK)



➤ Cholecystokinin (CCK from **Greek** *chole*, "bile"; *cysto*, "sac"; *kinin*, "move").

➤ **Source:**

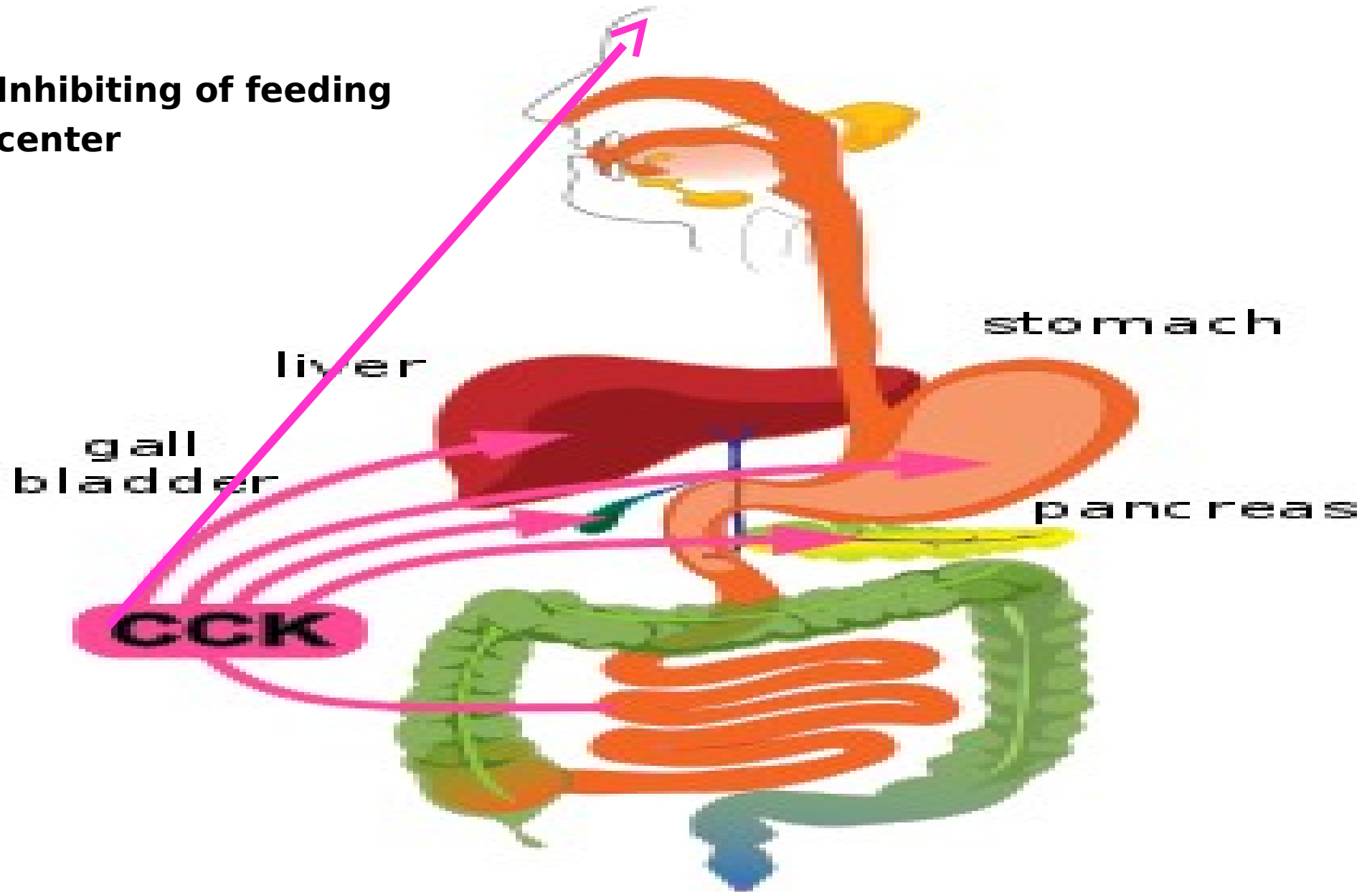
Is synthesized by **enteroendocrine** cells in **the duodenum**.

➤ It is released rapidly into circulation **in response to a meal**.

➤ **Function:**

- **Inhibiting** of feeding center (stop eating)
- **Delay gastric** emptying → give chance for digestion
- **Contraction of gall bladder** → release of bile which help in digestion
- **Stimulate release of pancreatic enzyme** in the small intestine.

**Inhibiting of feeding
center**



Peptide YY (PYY)-2



➤ Source:

It is a peptide released from ileum and colon in response to feeding.

➤ Action :

- **Inhibiting of feeding center**
- **Delay gastric emptying → give chance for digestion**

neural signals-2



- Mechanical:

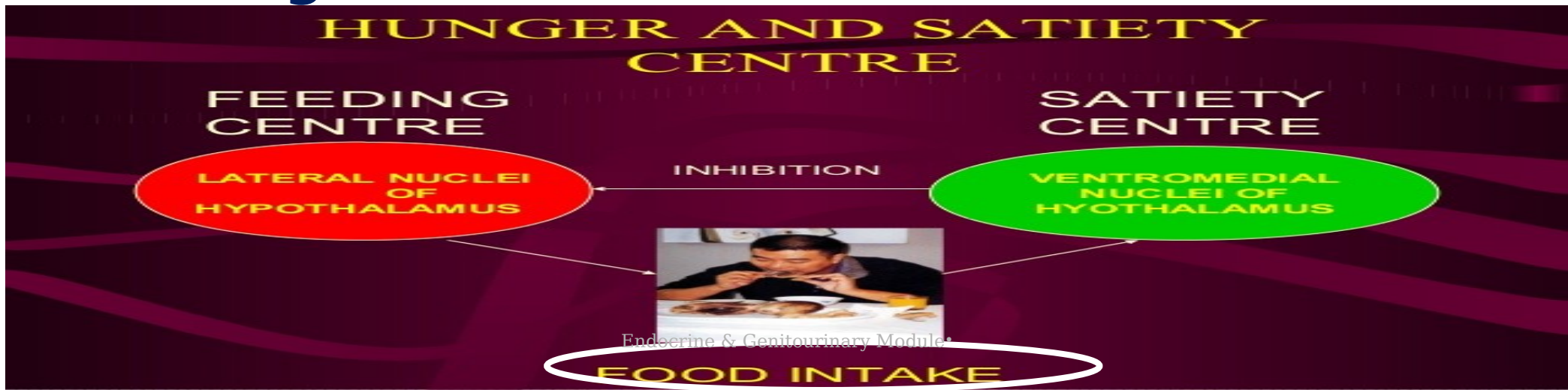
Stomach felling by food (**stretch**)
neural signals transmitted by vagi nerves
to the hypothalamus cause:

Stimulation of satiety center

Inhibition of feeding center

stop

eating



hypothalamus-3



The hypothalamus secrete neuropeptides such as:

i. Hormone:

Alpha melanocyte stimulating hormone (α -MSH): inhibit feeding sensation $\xrightarrow{\hspace{1.5cm}}$ satiety

i. Neurotransmitters:

such as serotonin and dopamine are important in regulating hunger and satiety.

Adipose tissue as endocrine organ



-Adipose tissue is now known to play an **active role** in body weight regulatory systems.

Adipose tissue is **an endocrine** cell that secretes a number of adipocytokine which act as **hormones** such as:

1-Leptin “**satiety hormone**”

2-



Adiponectin-2



- Site of synthesis:

produced in mainly from adipose tissue.

Physical exercise (activity) stimulate adiponectin secretion

- Function

- Reduces levels of blood free fatty acids.

- Improved lipid profile

Increase HDL cholesterol

Decrease LDL cholesterol

Decrease triglycerides

- **Increase** insulin sensitivity

better glycemic control and blood glucose level

- **Anti-inflammatory**

Reduce inflammation

Causes of obesity



1-Lack of energy balance :

A lack of energy balance most often causes overweight and obesity . Energy balance means that **energy IN** equals **energy OUT** .

2-An inactive sedentary life



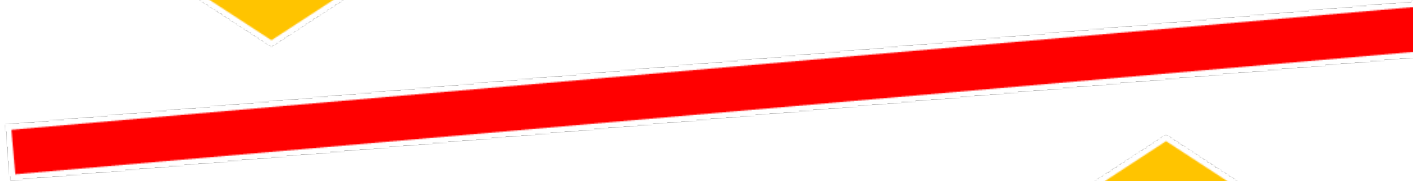
© Can Stock Photo - csp27743800





energy
through
physical

expenditure
metabolism and
activity



energy intake
from food
and drink



3-Environmental factors :

- Lack of sidewalk
- Oversized food portions
- fast foods
- Decreased consumption of healthy foods .



4-Genes and family history

Obesity has genetic basis??

➤ Identical twins have very similar body mass index (BMI) than those of non identical twins.

➤ **Gene Mutations :**

For example :some genetic mutation associated with :

- Hyperphagia
- Mass



5-Hormonal disturbances :

- Hypothyroidism
- Cushing syndrome
- Polycystic ovarian syndrome .



6-Medicines :

- Corticosteroids
- Antidepressant
- Antiepileptic



7-Emotional factors :

Some people eat more when they are bored, angry or stressed.

Normal



Cushing's



Causes of obesity



1-Lack of energy balance :

A lack of energy balance most often causes overweight and obesity . Energy balance means that **energy IN** equals **energy OUT** .

2-An inactive sedentary life



© Can Stock Photo - csp27743800





energy
through
physical

expenditure
metabolism and
activity



energy intake
from food
and drink



3-Environmental factors :

- **Lack of sidewalk**
- **Oversized food portions**
- **fast foods**
- **Decreased consumption of healthy foods .**



4-Genes and family history

Obesity has genetic basis??

➤ Identical twins have very similar body mass index (BMI) than those of non identical twins.

➤ **Gene Mutations :**

For example :some genetic mutation associated with :

- Hyperphagia
- Mass



5-Hormonal disturbances :

- Hypothyroidism
- Cushing syndrome
- Polycystic ovarian syndrome .



6-Medicines :

- Corticosteroids
- Antidepressant
- Antiepileptic



7-Emotional factors :

Some people eat more when they are bored, angry or stressed.

Normal



Cushing's



Effect of obesity



Metabolic changes associated problems



Dyslipidemias

- High total cholesterol level
- High LDL- cholesterol level
- Low HDL- cholesterol level
- High triglycerides level

2. Insulin resistance

3. Pre diabetes (impaired glucose tolerance)

health associated

1- Metabolic syndrome

2- other health associated problems

? What health problems associated with obesity



Obesity leads to increased risk of developing associated diseases, such as:

- **Arthritis.**
 - **Metabolic syndrome**
 - **Hypertension,**
 - **Cardiovascular disease**
 - **Cancer.**
 - **Fatty liver.**
 - **Depression**
 - **Gallbladder diseases**
- . Diabetes**
 - . Atherosclerosis**



Definition

A cluster of **metabolic abnormalities** associated with **Abdominal obesity** (**central obesity**)

Includes

- **Hyperglycemia**
- **Insulin resistance**
- **Dyslipidemia:** (Increased total cholesterol level and/or LDL-cholesterol and/or decreased HDL-cholesterol and/or increased triglycerides levels).
- **Hypertension**

Lecture Quiz



Which one of the following hormones increase insulin sensitivity?

A. Leptin

B. Adiponectin

C. Ghrelin

D. CCK

Lecture Quiz



Which one of the following hormones is hunger hormone?

A. Leptin

B. Adiponectin

C. Ghrelin

D. CCK

Calculate:

Calculate the BMI for a patient ,the weight of this patient was 85.5 Kg and the height was 155 cm.

Answer:

1.Firstly convert the height to meters:

$$155 \text{ cm} = 1.55 \text{ m}$$

2. BMI = weight (kg)/height (m²) = 85.5/(1.55)² = 35.6 kg/m².


SUGGESTED TEXTBOOKS



- **"Lippincott's Illustrated Reviews in Biochemistry" by P.C.Champe, R.A.Harvey and D.R.Ferrier**
- **"Harper's Biochemistry" by R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.**
- **Fundamentals of Clinical Chemistry (Tietz) Sixth**
- **"Textbook of Biochemistry with Clinical Correlations" by T.M.Devlin**
- **www.namrata.co- Biochemistry for medics**
- **Mahan LK, Escott-Stump S, Raymond JL, Krause MV. Krause's food & the nutrition care process. Elsevier Health Sciences; 2017.**

Helpful Websites

- **World Health Organization**
<http://www.who.int/topics/obesity/en>
- **Calculate your BMI**
<http://www.nhlbisupport.com/bmi/bminojs.htm>
- **Nutrition Facts**
<http://www.nutritiondata.com>



Thank You

Dr. Amal El-Shal